Space Weather Technical Forecast

Issued on Friday, 16 December 2022 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares (R1-R2 Blackouts) likely from AR3165.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity has been High with occasional M-flares observed in the last 24 hours, mostly from AR3165 (Eki/Beta-Gamma-Delta) with peak flare M5.7 at 15/2240 UTC from AR3165. There are six other sunspot regions on the visible disc. Of these AR3163 Ehi/Beta Gamma is the second largest region, a moderately sized spot in the southeast and moderately magnetically complex. AR3168 has slightly decreased in area, with the trailing spots fading away, and is currently classified as Hsx/alpha. The remaining regions on the disc are also relatively small, weak and magnetically simple, showing little or no development.
No Earth-directed CME's where observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed at L1 by DSCOVR and ACE have been at background levels, generally between 330 to 370 km/s. Density was mostly below average. The total IMF, Bt, was weak, below 8nT. The north-south component of the IMF, Bz, was negative early and late in the day, then fluctuated in-between, and was mostly weak. A maximum southward extent of -8nT was reached at 15/0640 UTC. The phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, have been at Background to Moderate levels, with peak 177 pfu at 15/1450 UTC. The associated 24-hour fluence decreased through the day, and remained well below Active (1e8 integrated pfu). Observed fluence at 16/0000 UTC was 2.44e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate, especially today and tomorrow before AR3165 rotates off the visible disc, with further M-flares. There is a slight chance of obtaining High levels again, with the maximum peak flare potentially reaching X-class. New active regions are expected to rotate onto the visible disc over the next few days.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs, although there is a slight chance of a glancing interaction on day 3 (18th) due to the filament eruption CME on the 14th, although this is expected to most likely pass to the south of Earth. Solar winds are expected to start at Background levels, and then increase to Slightly Elevated speeds at times during days 3 and 4 (18th and 19th), when the arrival of fast winds from CH54 could occur. Although the strength and timing of any enhancement is low confidence. Mainly Quiet (Kp 0-2) geomagnetic activity is expected, but with a chance of increasing to Unsettled to Active intervals (Kp 3-4), with a slight chance of G1 Minor Storms, from day 3 (18th).

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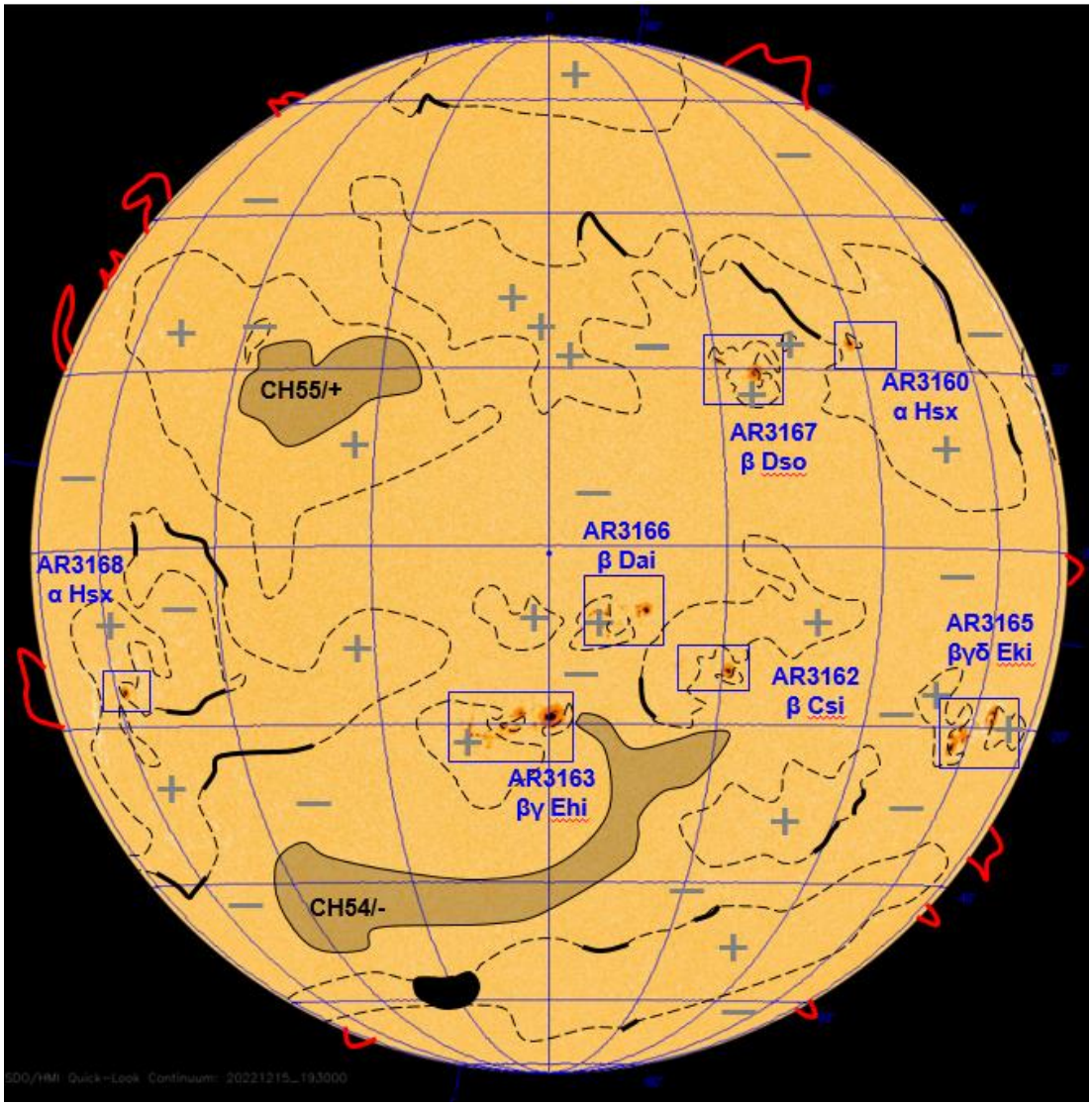
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels throughout, although there is chance of rising towards the S1 level with the occurrence of any notable flares. High energy (greater than 2 MeV) electron flux is currently at background to moderate flux levels and expected to persist at these levels. The associated 24 hour fluence is expected to continue well below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 15/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs. The filament lift off from the southwest around 14/0300 UTC has been assessed as missing Earth, but brings a very slight chance of glancing impacts during day 3 (18th).

Solar winds are expected to be at background to slightly elevated for much of the period, with the next enhancement being that from CH54/- currently in the southwest disc. This is a persistent feature, but reduced in size and northward extent compared to the previous rotation. However, its leading (western) edge is in a similar location, suggesting the timing of any enhancement that occurs is likely to follow the 27-day persistence, with solar wind speeds becoming slightly elevated at times from day 3 (18th) onwards, reaching up to 450 km/s. This arrival is not obvious in current MOSWOC ENLIL, therefore producing low confidence for a significant enhancement or any subsequent geomagnetic activity.

Mainly Quiet geomagnetic activity is expected, but with a chance of increasing to Unsettled to Active intervals, with a slight chance of G1 Minor Storms day 4 (18th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1530	Partial	M flare AR3153	SW	410	18/0800	Low confidence of a glancing blow

Figure 2: Solar wind persistence model.

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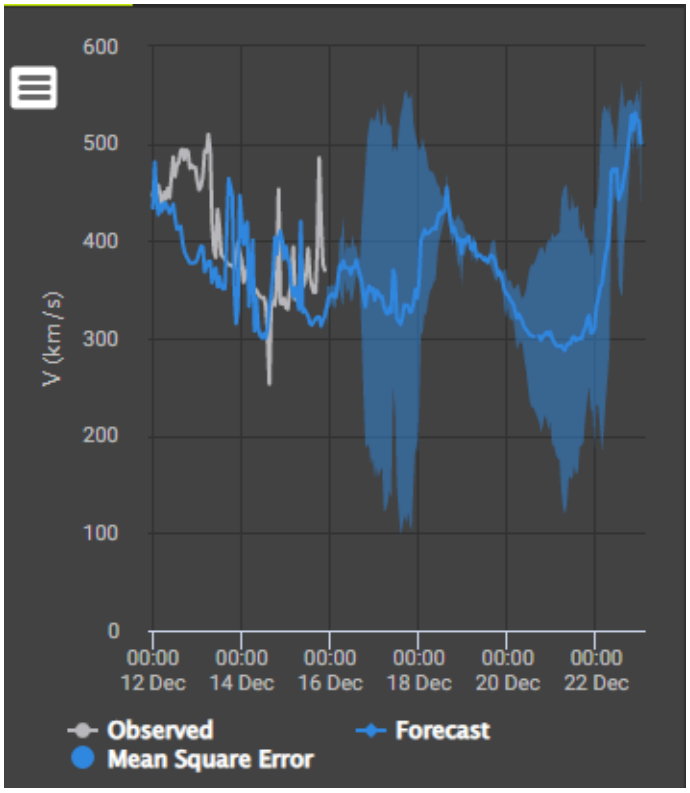
Met Office Space Weather Technical Forecast



Radio Blackouts - X-Ray Flares:

There are currently seven sunspot regions on the visible, the most active being AR3165. This region has recently elongated to become an Eki/beta-gamma-delta, with a delta spot still visible and asymmetric large leader spot, plus a very complex magnetic field. The still large but gradually shrinking AR3163, remains the second largest spot and maintains a complex magnetic beta-gamma structure. AR3168 has slightly decreased in area, with the trailing spots fading away, and is currently classified as Hsx/alpha. The remaining regions on the disc are also relatively small, weak and magnetically simple, showing little or no development.

Solar activity is forecast to be Moderate with further M-flares likely, and a slight chance of becoming high with the potential maximum flare reaching X-class.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	40	40
Very Active	R3 to R5 X Class	No	15	15	5	5

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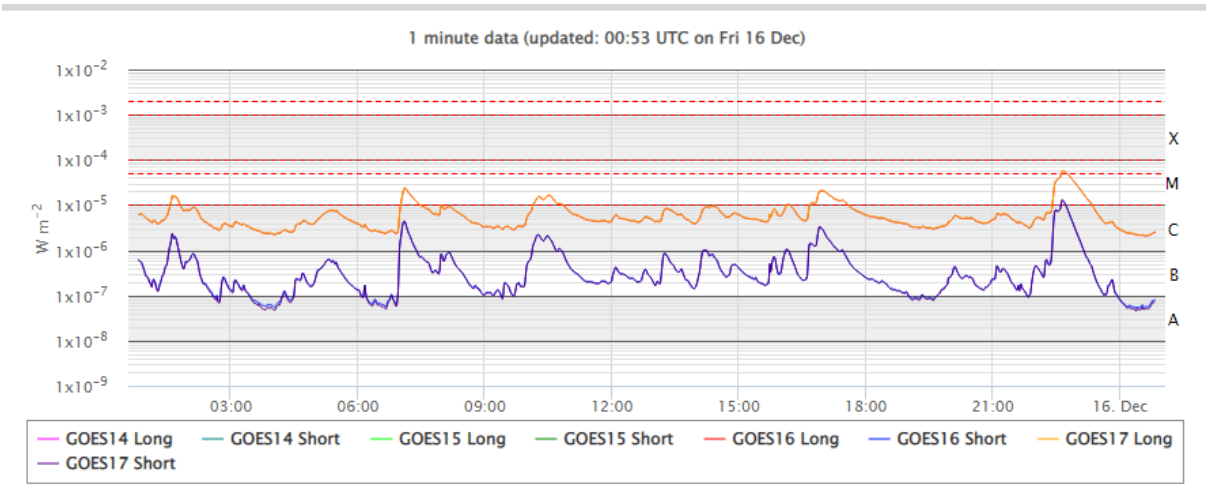
Figure 3: Latest GOES-16 X-ray flux, showing the recent M5.7 flare from AR3165.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 is expected to remain at background levels throughout. However the frequent M-flaring of AR3165 in the southwest, along with the number of other sunspots on the disc, brings a slight chance of flux levels rising, and potentially exceeding the S1 Minor Radiation Storm threshold.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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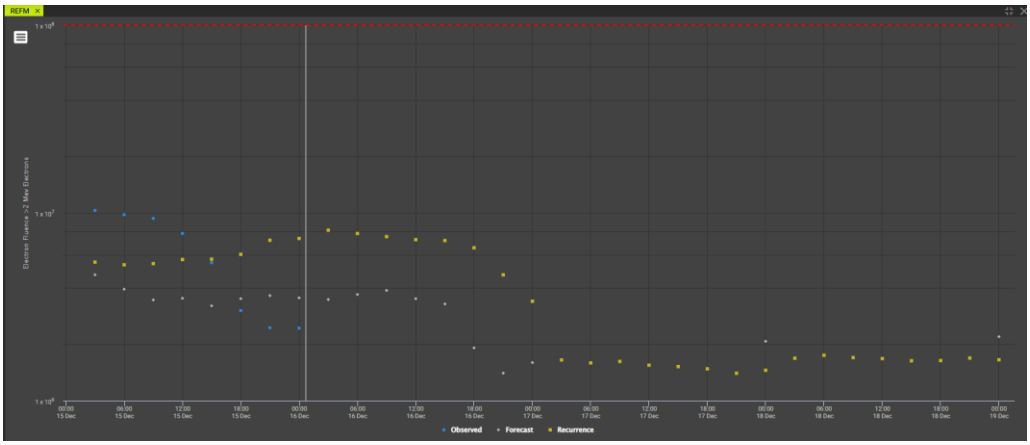
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux, as observed by GOES-16, is currently varying between Background and Moderate levels. With no significant solar wind enhancements expected, these electron flux levels are expected to persist through the period.
The associated 24 hour fluence is forecast to persist below the active threshold (1e8 integrated pfu). This is supported by REFM which is currently giving good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM



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